redhat.

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Beyond the latency: New metrics for the real-time kernel

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In the beginning

In the begin a program was only a **logical sequence**,
Then gosh said: we can't wait forever, we need to put **time** on this,

Since then we have two problems:
The **logical correctness**, and the **timing correctness**.

In theory...

The systems defined as a set of tasks τ

Each task is a set of variables that defines its timing behavior, e.g.,

$$\tau_i = \{P, C, D, B, J\}$$

Then, they try to define/develop a scheduler in such way that,

for each task i in τ:

the response time of $\tau_i < D_i$

For task level fixed priority scheduler:

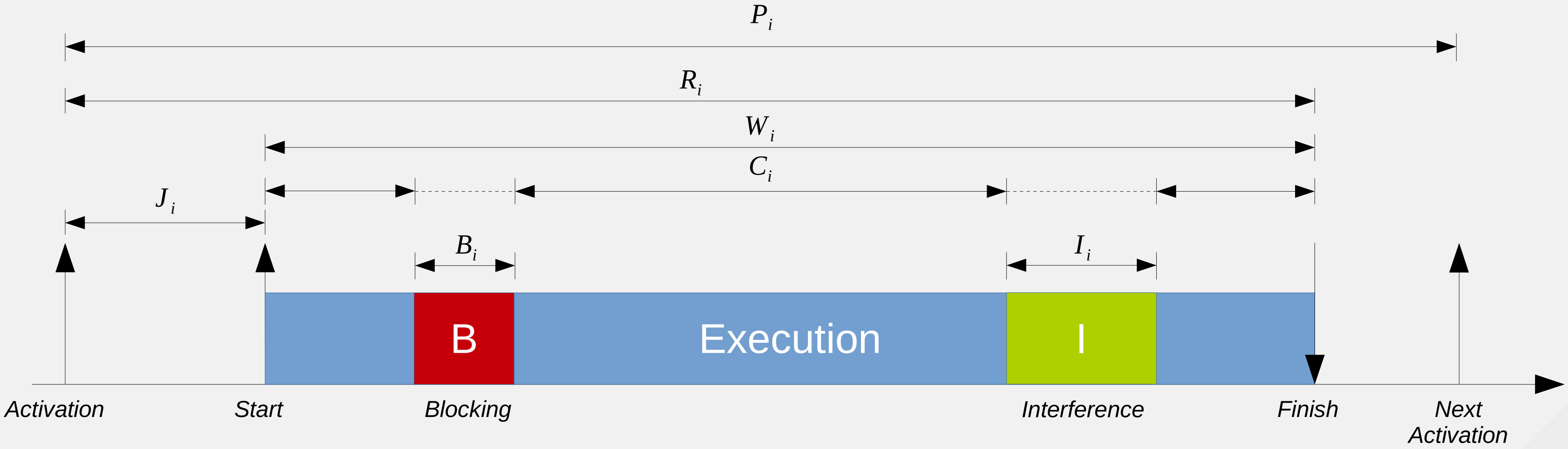
$\forall\, task\ i \in \tau$:

$$W_i = C_i + B_i + \sum_{j \in hp(i)} \left\lceil \frac{W_i + J_j}{P_j} \right\rceil C_j$$

$$R_i = W_i + J_i$$

$$is\ schedulable \Leftrightarrow \forall\, task\ i \in \tau \mid R_i < D_i$$

New metrics for the PREEMPT RT



PREEMPT_RT Timing correctness

- The preempt RT main metric is the latency
  - It is good, per carità...
- But it is very simplistic, if compared to response time.
- Latency is not even clearly defined
  - Kernel is seeing as a black box
  - There is no guarantee that the latency that took place now, will take place in the future (reproducibility/repeatability).
- It very hard, if not impossible, to give any guarantee in those numbers
  - We tried to use Extreme Value Analysis – it does not fit in the method.

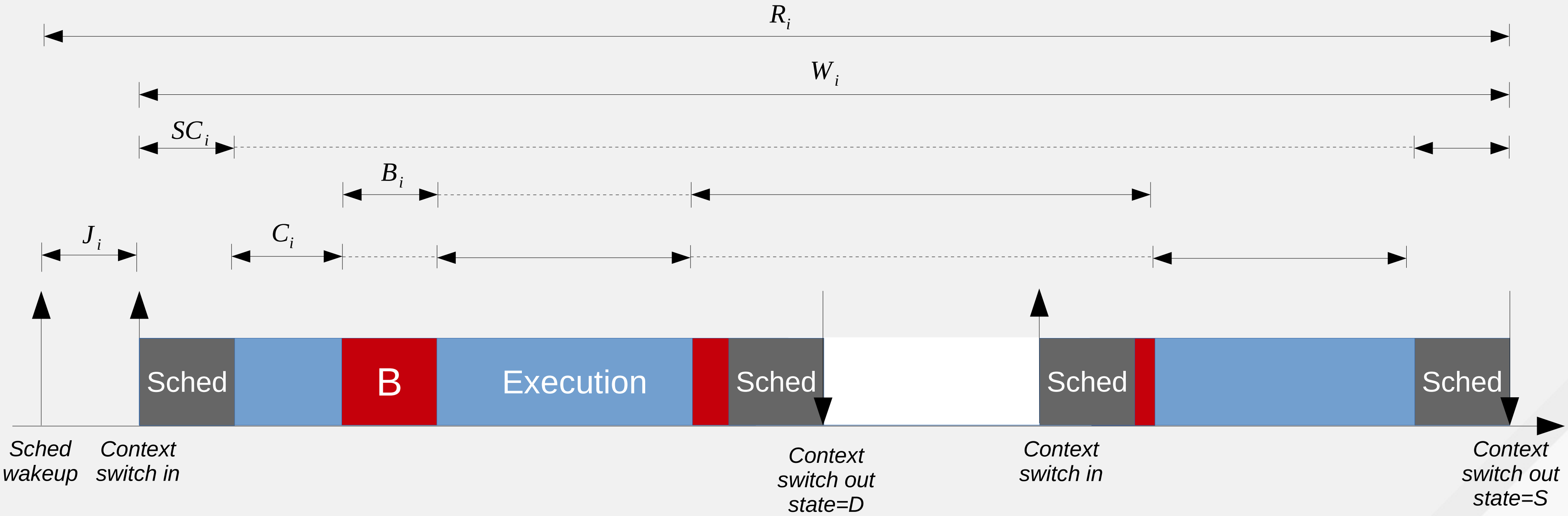
PREEMPT_RT Timing correctness

- User applications also depends on other characteristics of the kernel:
  - Locking
  - Dependence of other tasks
  - Interference of other tasks (and IRQs)

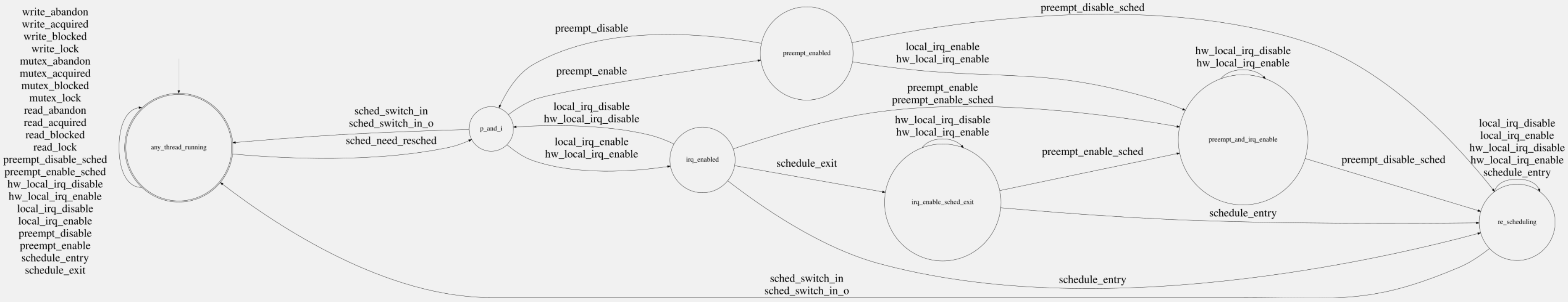
New metrics for the PREEMPT RT

- How can we improve the situation for Linux?
- What are tasks on Linux?
- What are the other metrics?
  - Execution time of task?
  - Blocking time? (SCHED_STATS)
    - Chain of locks that a task depends
  - Activation delay? (WAKEUP_DELAY)
    - Atomic context delay?
  - Dependency among tasks?

New metrics for the PREEMPT RT

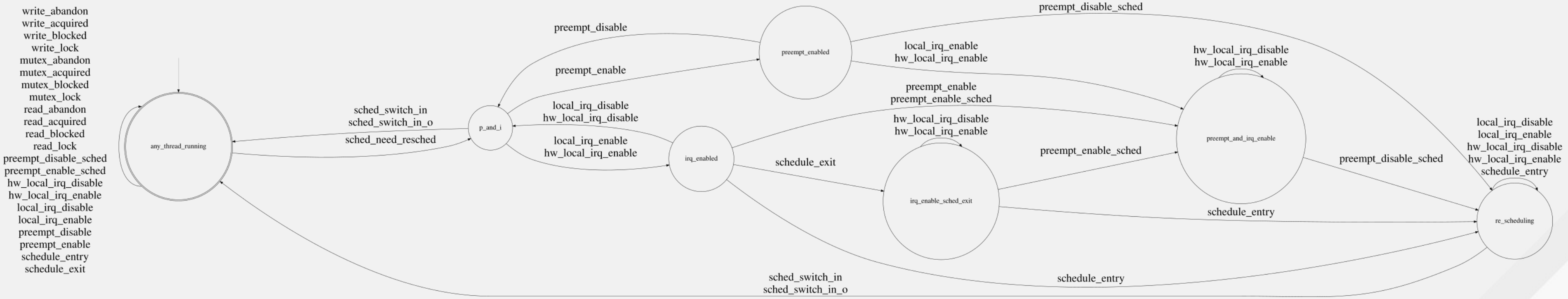


What will I do, e.g., Composition of Latency



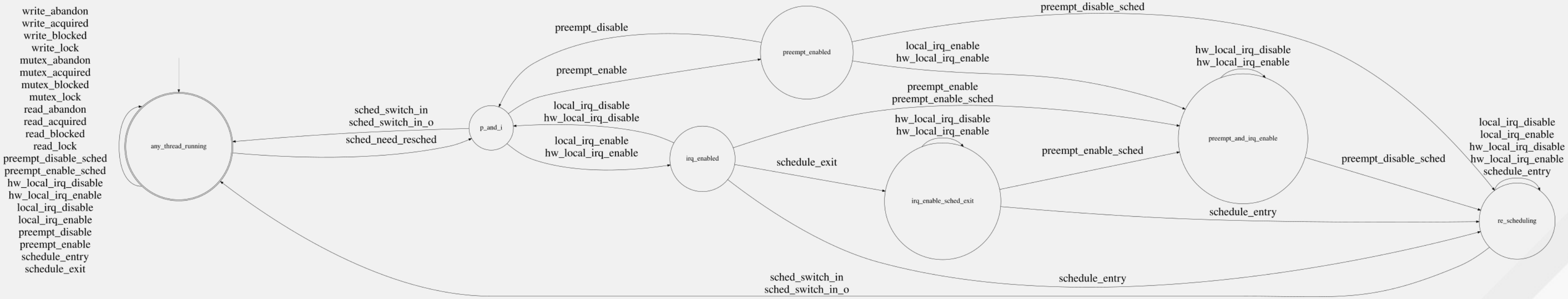
Rescheduling delay

- [need_resched...sched_return]
  - Case one: in the schedule



Rescheduling delay

- [need_resched...sched_return]
  - Case two: calling the scheduler
    - Consider also that we have interference from interrupts



Thoughts?

- It is not reasonable doing this only in user-space
  - Too much data
- Should I do a trace-plugin?
- Use eBPF?
- Do something in kernel (lock stat like?)